Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM28-P01 Room:Convention Hall Time:May 23 18:15-19:30

Spatio-temporal of the O+ outflow caused by enhancement of the solar wind dynamic pressure : KAGUYA UPI-TEX observation

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In 1980s, terrestrial Oxygen ion (O+) outflow was observed much more than expected amount in the polar region where the magnetic field connects to interplanetary space. However, it is not yet obvious when and how much O+ outflow are produced. The purpose of this study is to observe changing O+ outflow from the polar region when solar wind came with Upper Atmosphere and Plasma Imager -Telescope of Extreme ultraviolet (UPI-TEX). Observed spatio-temporal of O+ rexonance scattering emission is mapped with magnetic field model. Because O+ estimated by changing emission in and out magnetic line. As a result, O+ outflow observed by increasing the solar dynamic pressure. After it, O+ increased in magnetic line and it correlated with an aurora.

Keywords: KAGUYA Satellite, UPI-TEX, Oxygen ion, Magnetic field model, Geomagnetic activity

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PEM28-P02 Room:Convention Hall Time:May 23 18:15-19:30

Study of the relationships between auroral wave structures and the auroral acceleration region: Reimei observations

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Auroral wave structures are very dynamic phenomena: its growth and decay processes are complicated and attractive. Auroral electrons are considered to be accelerated in the accelerated region at several thousand km altitude. That is, potential structure in the acceleration region might affect the wave growth. However, the relationships between auroral wave structures and the auroral acceleration region, is not fully understood.In this study, we examined the growth process of the auroral wave structure during a quiet period of the magnetosphere.Using the Reimei observations, the 13 aurora waves events are selected during 2007 data. The characteristic energy is derived based on the inverted-V electron structures in the energy-time diagrams. Assuming the U-shaped potential structures, we then calculated an electric field perpendicular to the magnetic field from the space variations of the electron energy gain. As a result, we found that the time variations of the auroral wave is more active when the electric field and/or potential of the auroral acceleration region is enough strong.

Keywords: REIMEI Satellite, Aurora wave structure, Characteristic Energy, Inverted-V type electronic structure, Electron acceleration region

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PEM28-P03 Room:Convention Hall Time:May 23 18:15-19:30

The polarization of 4fce auroral roar emissions

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This is a report on the first polarization measurements of auroral radio emissions near 4 times the electron cyclotron frequency (f_{ce}) in the Earth's polar ionosphere. Sato et al. [2012] discovered auroral roar emissions near ionospheric $4f_{ce}$, which were detected with a passive receiver installed in Svalbard, Norway (Invariant LAT 75.1N). The initial observations, performed for about a year, showed that $4f_{ce}$ roar emissions were detected from 5.27 to 5.70 MHz during moderate geomagnetic disturbances in 22 days between May and September 2011 only from noon to evening, while no event occurred during the 2010-2011 winter season. Examination of 2011-2012 polarization measurement data in Iceland (Invariant LAT 65.3N) reveals four events of $4f_{ce}$ roar emissions. $4f_{ce}$ roar in two events was observed to be left elliptically polarized with respect to the local magnetic field during daylight hours. This polarization is consistent with the idea supported by the observation in Svalbard; the origin of $4f_{ce}$ roar is mode conversion to the L-O mode of upper hybrid waves favorably generated under the condition of $f_{UH} \sim 4f_{ce}$. The other two events showed that $4f_{ce}$ roar was right elliptically polarized during darkness hours. This polarization indicates that nonlinear coupling of two upper hybrid waves may also works in the bottomside auroral ionosphere to generate R-X mode $4f_{ce}$ roar.

Keywords: aurora, radio propagation, ground-based observation

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Ionospheric Alfven resonance observed at a low-latitude station, Wakuya

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Ionospheric Alfven resonance (IAR) can be identified in dynamic power spectrum plot as a spectral resonance structure in the frequency range of 0.1 Hz - 7.0 Hz. Most of previous studies about IAR were done for mid- to high-latitudes. Only a few studies reported IAR at low latitude station, Creta (33.1 deg geomagnetic latitude (GMLAT)) [e.g., T. Bosinger et al., 2004]. There is a report that no IAR was found near Tokyo [Hayakawa, 2004]. We, however, observed a clear signature of IAR in data obtained by an induction magnetometer at Wakuya (29.7 deg GMLAT). To our knowledge, this is an IAR observed at the lowest geomagnetic latitude. Then we performed a statistical study using the induction magnetometer data recorded at Wakuya from 2007 to 2009. The sampling rate of the data is 15 Hz. We identified IAR by a criterion that a spectral harmonic structure has three bands. IAR occurred from evening to dawn with the maximum occurrence rate around 0300 LT. There is a seasonal variation that few events were found in May to September, but there were a lot of events in October to April. The harmonic frequency gradually increases over evening to post midnight, reaches the maximum around 0300 LT, and then decreases until dawn. The average frequency difference between two adjacent harmonics dF also has seasonal change. dF is larger in winter than in summer. The occurrence rate of IAR has no clear relation to the Dst index, while it has a weak negative correlation with the Kp index.

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A Study of Field Line Resonances using data from the Magnetometer Array in the Tasmania and New Zealand Region

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In order to observe ULF pulsations and its spatial distribution around the terminator, we constructed a new magnetometer array in New Zealand and Tasmania region. In February 2011 and March 2012, we installed magnetometers in Middlemarch and Te Wharau, respectively. Coordination of them and other magnetometers operated by other projects allow us to study temporal variations of frequency of field line resonances in the Tasmania and New Zealand meridian lines. In this paper, our latest results are introduced.

Keywords: field line resonance, plasmasphere, inner magnetosphere, ULF wave, magnetosphere-ionosphere coupling

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Stereo measurement of auroral emission altitudes using circular fisheye digital cameras

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The 3D structures of aurora tell us important information on the energy of precipitating electrons as well as the mechanisms. The purpose of this study is to estimate the emission altitude of aurora using pictures by digital cameras. It is fundamental to pursuing the altitudes and morphology of aurora in detail using new imaging instruments to advance our understanding of the generation mechanism of the aurora. We have been challenging a stereo imaging of aurora since 2009 using digital cameras equipped with fish-eye lens in Alaska. We installed two digital cameras for the time lapse observations with 3-60 s intervals; one is installed at the Poker Flat Research Range (PFRR) of University of Alaska, Fairbanks and the other is installed near the PFRR. For three winter seasons, we conducted a variety of experiments with different separation distance (3-8 km) and with a different set of cameras using Nikon D90, D7000, D3s, D3x,and D4. There are several advantages of digital cameras against to usual CCD observations such as high spatial resolution, full-color observations, and low-cost operations. A number of images more than 3 TB have been obtained for three seasons. In order to estimate the emission altitudes, we firstly estimate the camera parameters to calibrate the fish-eye images into absolute coordinate using the star positions [Mori et al.,2012]. We then apply plane sweep method to find the altitudes of maximum correlation of two images changing the mapping altitude and estimate the possible altitudes of aurora. We estimated the possible auroral altitudes for 13 examples, and the altitudes are distribute in 110-160km.

Keywords: auroral altitude, plane sweep, stereo fisheye digital cameras

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PEM28-P07 Room:Convention Hall Time:May 23 18:15-19:30

Simultaneous measurement of auroral O I 630.0nm polarization using an all-sky polarimeter and a scanning polarimeter

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Auroral O I 630.0nm emission is expected to be polarized at a maximum polarization degree of 15% when it is collisionally excited by directive electron (Percival and Seaton 1958; Bommier et al., 2011). Because observed maximum polarization degree is mainly a function of pitch angle distribution of impact electrons, a polarimetry of aurora could be a new remote-sensing technique to derive impact electron information, especially for its pitch angle distribution. In this study, we aimed to establish procedures of all-sky polarimetry and to derive all-sky distribution of polarization.

Observation of auroral polarimetry was made at Poker Flat Research Range in Alaska from 6 through 19 February 2013 using a all-sky polarimeter and a scanning polarimeter. The all-sky polarimeter which consists of an all-sky imaging optics, two liquid-crystal variable retarder, a polarization beam-splitter and two CCD cameras enables to measure Stokes four parameters (IQUV). The scanning polarimeter which consists of a quarter-wave retarder with a rotation stage, a polarization beam splitter, and two photon multipliers enables to measure Stokes four parameters as well.

Based on a preliminary result from all-sky polarimeter, degree of linear polarization increases from 0 to 2% with increase of angle between line-of-sight and local magnetic field. The result indicates that the measured distribution of polarization would be made by precipitating electron impact. In the presentation, we will introduce a typical substorm event on 10 January to see some relationship between degree of polarization and pitch angle distribution of precipitating electron.

Keywords: polarimeter, auroral, O I, 6300

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Observation of low-latitude aurora by color digital cameras in Hokkaido

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Auroras observed in the middle latitude regions during a strong geomagnetic storm are called ”low latitude auroras”. Characteristics and mechanism of the low latitude aurora are still not fully understood due to a relatively low occurrence probability. Shiokawa et al. [2005] summarized low latitude aurora events observed with a sensitive optics (an imager and a photometer) at Moshiri (44.4^{o}N) and Rikubetsu (43.5^{o}N) in Hokkaido during 1999-2004. According to Shiokawa et al. [2005] several events in which OI 630.0 nm auroral emission showed visible level brightness ($>$ several kR) were recorded while SAR arcs appeared during the recovery phase of a geomagnetic storm. Although there are no explicit reports of naked eye observations during the events in their report, several color images of low latitude aurora were taken at the Nayoro observatory in Hokkaido (44.4^{o}N) in the same periods (6 nights between Mar 31 2001 and Nov 10 2004). In this presentation comparison between parameters estimated from these new color images and results from Shiokawa et al. [2005] are performed.

Keywords: Low latitude aurora, magnetosphere, imaging, Hokkaido, Nayoro

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Statistical analysis of auroral breakups during magnetic storm

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On average, auroral breakups typically initiate near 67deg magnetic latitude (MLAT) and in the pre-midnight region (23 hour in magnetic local time (MLT)). We statistically studied locations of auroral breakups during magnetic storms.

Auroral breakups were identified using global images taken by the ultraviolet imager onboard Polar satellite. We divided auroral breakups into storm-time events and other events, and then studied their differences. We identified magnetic storms with using Sym-H geomagnetic index and the sudden commencement(SC).

Our results show that auroral breakups occur at later MLT during the storm main phase than during other phases. This result is supported by preliminary studies of associations between the interplanetary magnetic field and breakups MLT.

Keywords: aurora, agnetic storm

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Status report on the SuperDARN Hokkaido East / West radars (2013.2)

Nozomu Nishitani[1*], Tomoaki Hori[1], Mariko Teramoto[1], Tadahiko Ogawa[2], Takashi Kikuchi[1], Akira Sessai Yukimatu[3], Masaki Tsutsumi[3], Katsuya Sakoyama[1]

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Latest status report on the SuperDARN Hokkaido East / West radars will be presented. The Hokkaido East radar has been operating since Nov. 2006 continuously. The Hokkaido West radar has been approved for funding.

Keywords: SuperDARN Hokkaido East / West radars, ionosphere, magnetosphere, thermosphere, dynamics, international collaboration

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Syowa SENSU SuperDARN imaging radar and the future perspective (2)

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SENSU Syowa HF radars are important components of SuperDARN, the international HF radars network since 1995 and have significantly contributed to understanding not only magnetosphere-ionosphere system and their couplings but also MLT region dynamics. As SuperDARN radars were originally designed to reveal global polar ionospheric plasma convection patterns in both hemispheres in real time, its spatial resolution has been relatively low. As the number of new scientific targets like comparison with mid and small scale aurora phenomena, meso scale transient phenomena, elementary generation and decay process of field aligned irregularities, PMSEs and fine height profile of neutral wind have been increasing, higher spatial (and temporal) resolution observations have been essentially desired and of great importance. Imaging radar technique has been tried to be applied and developed to overcome these issues. We show the current status of our preparation of the SENSU imaging radar system, and will discuss particularly on the scientific targets and the future perspectives which can be revealed by this new technique using SuperDARN.

Keywords: SuperDARN, Syowa, imaging, MI coupling, aurora, MLT region

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Deriving maps of field-aligned current from IMAGE FUV and SuperDARN

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Many efforts have been made for deriving the spatial distribution of field-aligned currents (FACs) in the high-latitude ionosphere. To date, however, it has been still difficult to construct a map of FACs as a snap shot without any assumptions. In this study, we employ the ionospheric conductances estimated from the IMAGE/FUV auroral images together with the electric field deduced from Super Dual Auroral Radar Network (SuperDARN), and then derive a map of FACs in the high-latitude. The primary objective is to visualize the mesoscale structure of FACs in the vicinity of auroral bulges. If the 2D distribution of the bulge-associated FACs is clarified, the closure of the substorm currents can be discussed in terms of the magnetosphere-ionosphere coupling system. We have estimated the distribution of FACs for two case examples, one on September 25, 2001 and the other on January 12, 2002. During both intervals, nicely developing auroral bulges were observed by the IMAGE satellite and lots of backscatter echoes were obtained by the SuperDARN radars, which is a favorable condition for estimating the distribution of FACs in the vicinity of auroral bulge. We demonstrate how the procedure works in deriving the FAC system and discuss the closure of the substorm current system from the initial results.

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MLT dependence of the response of ionospheric electric fields at mid-low latitude during geomagnetic sudden commencement

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SC is caused by MHD waves transmitted toward the ionosphere associated with the compression of the magnetosphere due to solar flare disturbances. The characteristic of its variation is explained by the 3-demensional current systems composed of the Chapman-Ferraro current, the field-aligned current, and the ionospheric current[Araki,1994]. It is known that SC is accompanied with the instant transmission of the electric field, which is found in the ionosphere derived by the HF Doppler[Kikuchi,1986] and in the plasmasphere observed by Akebono[Shinbori et al.,2006]. Nishimura et al.(2010) indicated the upward Poynting flux at the plasmaspheric electric field derived by Cluster observation. They showed the electric field transmission from ionosphere to polar magnetosphere, and estimated that plasmaspheric electric fields during SC originate in the ionosphere. The ROCSAT-1 is rare satellite in terms of in-situ observation of the ionospheric electric field. It had orbited at the altitude of 600km, and observed during the solar maximum, thus it has detected many SC events[Shinbori et al.,2009]. This data indicates the Preliminary Impulse(PI) or Main Impulse(MI) electric field variation[Su et al.,to be submitted]. However, the simultaneity to geomagnetic variation and the MLT distribution of the electric field have not investigated. We need to clear them to understand the convection process of the electric field. Therefore, we will eliminate effects of the magnetospheric current and the ionospheric conductance by in-situ observation, and analyze the time and spatial evolution during SC. Underlying data are the drift velocity observed by the Ionospheric Plasma and Electrodynamics Instrument(IPEI) onboard ROCSAT-1, and we derived in-situ electric fields with the IGRF-10 model. We referred geomagnetic field variations from 8 stations where has sampled per a second. We selected the SC events from the list of Shinbori et al.(2009), with the following criteria; (1) IPEI observation is available(1999/3/11˜2004/6/13), (2) the PI amplitude more than 2nT near the dayside magnetic equator, and (3) the Preliminary Reverse Impulse(PRI) signature at both high latitude and daytime magnetic equator. We identified 203 events under the above conditions, and 44 events showed that SC signatures detected on the ground is synchronized to the onset at the ionospheric electric field. At these events we could detect the ionospheric electric field variation corresponding to the PI and MI signature of geomagnetic fields. This result indicates that PRI and MI signatures of the electric field are potential fields associated with conduction currents, and instantly transmit globally. We confirmed that the ionospheric electric field was changed simultaneously with geomagnetic variations even if they observed at different MLT locations. For events which are seen relatively massive electric fields, we pursued Superposed Epoch Analysis. We extracted events which PI was detected in the electric field, and derived the LT distribution of PI in the electric field after regarding the PI peak time of each electric field as the time reference. Therefore, we showed that the PRI appears at 6-21 LT, while the Preliminary Positive Impulse(PPI) at 21-6 LT, which is consistent with Kikuchi et al.(1985) senario. Also we first detected the evening enhancement by in-situ electric field observation. This result is similar to the daily variation of equatorial ionospheric electric fields[Fejer et al.,1991], and we estimate the relation of the electric field originated by the magnetosphere. Our results show that equatorial ionspheric electric fields transmit instantly, and that it is caused by the transmission of convection electric field from polar region. And the detection of the evening enhancement means that the transmission process during SC is similar to what causes the daily variation, and suggests that its process is affected by the electric field transmission from magnetosphere.

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Ionospheric current identified by propagation characteristics of Pc5 and DP2

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It is well known that DP2 variation observed at the equator is a result of constructing of ionospheric current between polar regions and equator [Kikuchi et al., 1996]. Furthermore, Motoba et al., [2002] mentioned that global Pc5 can be caused by current systems similar to DP2 current system in Ionosphere. However, mechanism and propagation path of such global current especially between polar regions and equatorial ionosphere are not well known.

To clarify connection path of ionospheric current system between polar and equatorial ionosphere, we analyzed global distribution of ULF pulsations using MAGDAS/CPMN network [K. Yumoto et al., 2006 and 2007]. In this study, we especially focus on polarization, amplitude and LT dependence of ULF pulsations. The electric field data observed by HF radars are used for identification of Cowling effect at the dip-equator and dawn-dusk terminator.

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Multi-timescale statistical analysis of ionospheric trough with long-term EISCAT dataset

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The statistical analysis to northern ionospheric auroral/subauroral trough has been conducted for the purpose of clarifying the controlling mechanism of the trough's basic structure.

Ionospheric trough, known as an electron density depletion region in ionosphere, is considered as one of the important phenomena driving the coupling system between ionosphere and magnetosphere via magnetic-field-lines. Therefore the trough research is not only restricted to ionospheric physics but also could contribute to magnetospheric physics, especially magnetosphere-ionosphere coupling system. Moreover, it is indicated that sharply decreasing of electron density over the tough wall region could influence the HF radio wave propagation and GPS navigation system. Thus the trough research is expected to make contribution to radio communication science.

It is commonly accepted that the dissociative recombination caused by ionospheric heating generates the trough's basic structure. However, it is very difficult to reveal the causal relationship between several heating mechanisms and trough's characteristics because various physical and/or chemical processes could drive depletion of ionospheric density. In this study, therefore, we have used EISCAT database which covers 29-years (1983~2011) ionospheric data and conducted long-term statistical analysis of the ionospheric trough. In particular, we focus on investigations of the characteristics of the trough's spatial structure by using multi-timescale statistical analysis. We have obtained the following results so far.

(1) Nighttime trough is steadily structured in all seasons, while structure of daytime trough has seasonal dependence because ionization rate is controlled by solar zenith angle.

(2) The longitudinal structure of trough shifts equatorward and toward pre-midnight with increasing Kp index.

(3) While the background electron density becomes higher in F-region, the depth of trough becomes deeper with increasing F10.7 index.

In this paper, we present the analysis method and the obtained results, and discuss how the characteristics are generated.

Keywords: EISCAT, Ionosphere, Trough

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Plasma density structure at scales of a few kilometers in the cusp

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We have examined kilometer size density structure in the dayside cusp by using in-situ measurements made by DE 2 spacecraft. We analyzed high time resolution (16 milli-second) ion density data, and examined the occurrence characteristics of relatively large amplitude structures at scales of a few kilometers in terms of the background plasma density gradient, ion drift, and electron temperature. The result shows that the occurrence of the plasma density structure is high in the fast flow region, which is typical for the cusp, and in the region adjacent to and poleward of that region.

Keywords: cusp, plasma density structure, plasma flow, electron temperature

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Observation of GNSS scintillation in Tromso

Yusaku Ito[1*], Yuichi Otsuka[1], Kazuo Shiokawa[1], Keisuke Hosokawa[2], Yasunobu Ogawa[3]

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A radio signal passing through small-scale irregularities in the ionospheric electron density fluctuates in amplitude and phase because the irregularities act as diffraction gratings. This phenomenon is known as scintillation. The GNSS(Global Navigation Satellite System) scintillation is caused by irregularities with scale-size of several hundred meters. In this study, we install GNSS receivers at the EISCAT radar site in Tromso, Norway, where optical and radio measurements are carried out. On January, 2012, we have installed a GNSS receiver at EISCAT radar site in Tromso, Norway. The receiver has an ability to measure phase and signal-to-noise ratio of the radio wave at dual frequency (L1 and L2) at 50 Hz, so that total electron content and phase and amplitude scintillations can be obtained. On September, 2012, we have installed two more receivers. Mutual distances between the GNSS receivers are 172m, 242m and 218m, respectively. Drift velocities of irregularities can be measured using cross-correlation analysis with the time series of the GNSS signal intensity and phase obtained from the three receivers.